TACCIMO USER GUIDE 2.2

Template for Assessing Climate Change Impacts & Management Options

Emrys Treasure, Steven McNulty, Jennifer Moore Myers, and Lisa Nicole Jennings

The Authors:

Emrys Treasure, Biological Scientist; **Steven McNulty**, Supervisory Ecologist; **Jennifer Moore Myers**, Resource Information Specialist, U.S. Forest Service, Southern Research Station, Eastern Forest Environmental Threat Assessment Center, 920 Main Campus Drive, Suite 300, Raleigh, NC 27606; and **Lisa Nicole Jennings**, Climate Change Outreach Specialist, North Carolina State University, College of Natural Resources, Department of Forest and Environmental Resources, Campus Box 8008, Raleigh, NC 27695.

TACCIMO Development Team (in addition to authors listed above): **Chris Liggett**, Planning Director; **David Meriwether**, Ecosystem Management Coordinator; **Paul Arndt**, Regional Planner, U.S. Forest Service, Southern Region, 1720 Peachtree Road NW, Suite 811N, Atlanta, GA 30309; **Nancy Grulke**, Director, **Lisa Balduman**, Technical Information Specialist, U.S. Forest Service, Western Wildland Environmental Threat Assessment Center, 3160 NE Third Street, Prineville, OR 97754; and **Robert Herring**, IT Specialist, U.S. Forest Service, Southern Research Station, Eastern Forest Environmental Threat Assessment Center, 920 Main Campus Drive, Suite 300, Raleigh, NC 27606.

Cover: Mature bottomland hardwood forest. (U.S. Forest Service)

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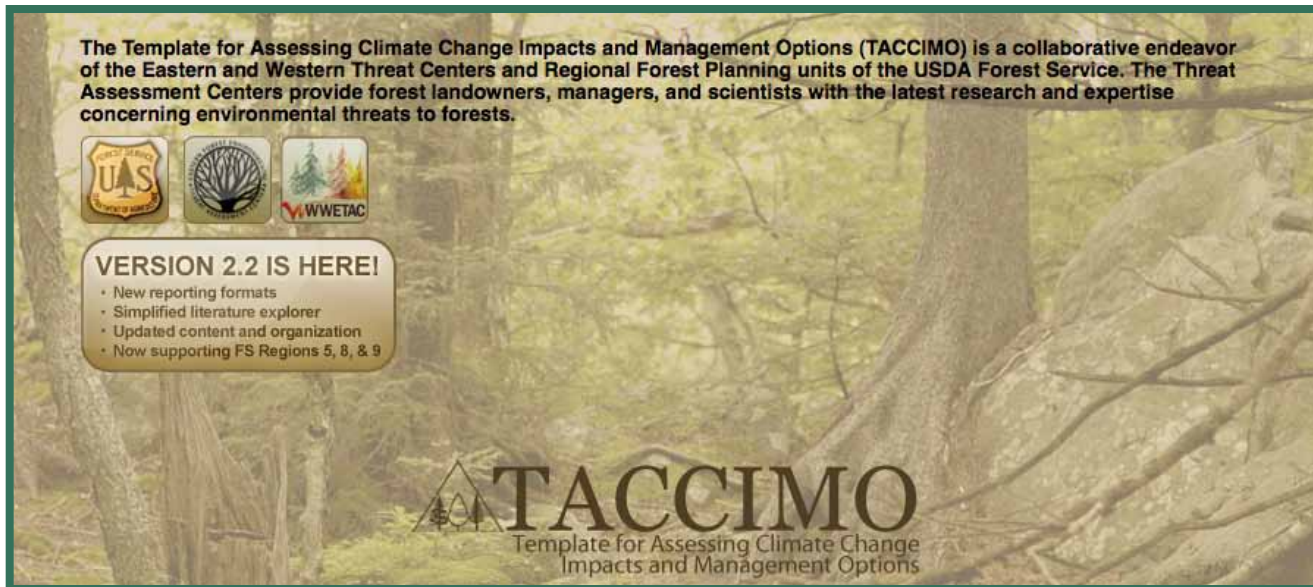
TACCIMO USER GUIDE 2.2

Template for Assessing Climate Change Impacts & Management Options

The Template for Assessing Climate Change Impacts and Management Options (TACCIMO) is a collaborative endeavor of the Eastern and Western Threat Centers and Regional Forest Planning units of the USDA Forest Service. The Threat Assessment Centers provide forest landowners, managers, and scientists with the latest research and expertise concerning environmental threats to forests.

VERSION 2.2 IS HERE!
- New reporting formats
- Simplified literature explorer
- Updated content and organization
- Now supporting FS Regions 5, 8, & 9

TACCIMO
Template for Assessing Climate Change
Impacts and Management Options

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**Template for Assessing
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ABSTRACT

The Template for Assessing Climate Change Impacts and Management Options (TACCIMO) is a Web-based tool developed by the Forest Service, U.S. Department of Agriculture to assist Federal, State, and private land managers and planners with evaluation of climate change science implications for sustainable natural resource management. TACCIMO is a dynamic information framework focused on assisting natural resource professionals with the integration of climate change into decision-support processes. A searchable repository of peer-reviewed climate change literature on effects and management options is accessible through a Web-based tool. A geospatial mapping application provides high-resolution climate data and other spatially explicit models relevant to evaluating climate change impacts on forests through modeling. Report generators assist users in capturing outputs specific to a given location and resource area in a consistent, organized manner. For Forest Service users, science findings can be readily linked with management conditions and capabilities from national forest land and resource management plans. Collectively, the TACCIMO tools provide a fast, concise, and creditable starting point to guide critical thinking, additional analysis, and expert consultation supportive of resource management decisionmaking.

Keywords: Climate change, decision support, forest planning, technology transfer.

INTRODUCTION

The Template for Assessing Climate Change Impacts and Management Options (TACCIMO; http://www.forestthreats.org/taccimotool) is a Web-based tool for technology transfer and science-management integration. This interactive resource provides landowners, managers, and planners with comprehensive summaries of the climate change science needed to assess, manage, and monitor forest resources. The goal is to develop and implement technology, in turn fostering informed and transparent interactions between scientists, forest managers, and the public. Connecting planning with climate change science enables planners and managers to efficiently consider current management capabilities, reconcile them with scientific findings, and validate or modify management direction.

This guide is designed and written to assist professional users (e.g., forest planners, extension professionals) who are familiar with natural resource concepts and the role that science plays in decision support. For interested lay audiences, there is specific information, including videos and help documentation, imbedded in the TACCIMO Web site. The body of this guide includes introductory information covering the TACCIMO concept, step-by-step instructions with screen captures, detailed descriptions of outputs, and general terms of use. Supplemental information that is potentially important, but not essential, is available in a series of appendices. Strategic context is discussed in appendix A, content development methods are shown in appendix B, and examples of connections with specific decision-support frameworks are given in appendix C.

Although this guide wholly represents the functionality and organization of TACCIMO's current version, the content within the tool is constantly evolving.

TACCIMO is more fully developed for certain regions and subjects than for others, and content development is prioritized based on users' needs. As a result, certain regions and subjects contain considerable breadth and depth of coverage; others may include only very general information or are omitted altogether. At the time of publication of this user guide (December, 2013), U.S. Department of Agriculture Forest Service Regions 8 (Southern), 9 (Eastern), and 5 (California) are most fully represented across all content types. However, all regions are represented in TACCIMO's content, as there is a great deal of information across subjects that is generally relevant at a national extent.

Rationale

There is an ever-increasing volume of useful scientific knowledge about climate change effects and management options for forest ecosystems. In addition, information transfer mechanisms specifically focused on climate change implications for natural resource management are needed (app. A). The combined volume of existing information, rate of development of new information, and limited standardized transfer mechanisms make efficient access and use difficult. TACCIMO accesses this abundance of information and focuses on what forest planners and managers need. TACCIMO's flexible framework allows new information to be added routinely and existing information to be reorganized. Automated features add value to the information by combining relevant content both within science (i.e., linking effects and management options) and between science and planning. In addition, spatial data help users ask informed questions and quickly derive results specific to their location.

Identifying Problems and Connecting Solutions—A major challenge in applying science to support planning and management decisions is the need to readily connect effects of climate change with appropriate management options. These key pieces of information are not always addressed together in scientific literature. TACCIMO helps remedy this problem by systematically associating effects and management options from different sources and compiling them into a single reference resource based on simple methods and criteria.

Linking Science with Planning—The Forest Service has developed a wealth of forest management knowledge in the form of forest plans. These plans include desired conditions as well as more specific objectives and design criteria that guide the forest toward sustainability. Similarly, the scientific understanding of climate change is a maturing discipline that is working to address forest

management information needs. TACCIMO facilitates this connection by directly linking scientific and land management planning information based on subject. The ability to readily relate this information supports a standardized and repeatable approach to assessing management conditions and emerging science in an adaptive management context (see app. C).

Establishing the Range of Future Climate—For the purposes of planning and forest management, it is important to know the likely range of projected climate change. However, it is time-consuming and difficult to navigate the many projections at different temporal and geographic points. TACCIMO simplifies this process by identifying a set of projections that mark the bounds of future climate specific to a location in the context of regional and national trends. In addition, TACCIMO provides access to derivative models that help users evaluate the impacts of climate change on ecosystem characteristics and functions.

Inputs and Outputs

The TACCIMO Web site provides the interface for accessing science (geospatial maps and literature) and planning content through exploration and report generation tools (fig. 1). The Web site also serves as an efficient means for connecting users with TACCIMO support services and links to other external resources. This section briefly describes TACCIMO inputs and outputs (refer to app. B for detailed descriptions).

Inputs—Content is structured around a dynamic science delivery framework containing three general content areas:

Science: Geospatial (maps)—Geospatial science includes temperature and precipitation data from a range of global climate models (GCMs) and emissions scenarios. Derivative models, which use climate as an input parameter and project ecosystem changes, are also included. Natural resource context layers (e.g., ecoregions, watersheds) are included to allow users to explore geospatial content with familiar context.

Science: Literature—Literature-based science includes an extensive and growing inventory of peer-reviewed literature capturing highlighted quotations describing climate change effects and management options. The literature inventory provides users with subject and geographically organized literature supporting further review and analysis.

USDA FS Forest Planning—Forest plan components, the decision elements of forest planning, are organized and compiled for selected regions of the National Forest System (NFS). With this resource, users can readily evaluate climate change implications for existing management direction and capabilities.

Outputs—The public-facing TACCIMO Web site offers informative views in two key functionality areas:

Explore—The *Explore* module enables easy, intuitive user orientation and self-education.
  • *Literature Explorer* has two modules; one enables review and interactive filtering by subject, the other by geographic region.
  • *Forest Plan Explorer* enables review and interactive filtering of forest plan components.
  • *GIS Viewer* enables review of climate data, including interactive tools and relevant context layers.

Generate A Report—The *Generate A Report* module produces structured and exportable documents through a series of basic selections.
  • *Climate Report* produces a summary of projected future climate at the national, regional, State, county, and national forest extents focused on capturing the range of potential change.
  • *Literature Report* builds a custom report of highlighted science.
  • *Literature and Planning Report* adds relevant NFS plan components to the highlighted science. The *Planning Report* allows for report generation from NFS plan content independent of science content selections.

Figure 1—Conceptual diagram depicting the inputs and outputs of the TACCIMO system.

Key Definitions

TACCIMO uses terms that have specialized meaning in this context, despite being commonly used words with generally understood definitions. These terms describe and organize the literature-based content and are defined briefly here (alphabetically) to aid users in interpreting the remainder of this guide (refer to app. B for additional detail):

Category—A more specific grouping system within factors in TACCIMO's hierarchical organization. For example, the factor air quality contains ozone, nitrogen, and mercury categories. Categories assist users in narrowing content selections to those most relevant to their particular needs.

Content Resolution—This description captures the level of detail expressed in an effect or management option. Content resolution supports the relationship-building process between effects and management options and plays a role in report organization.

General—For use during strategic planning, but typically lacks actionable information and is primarily useful in evaluating and formulating desired conditions.

Moderately Specific—Supports information needs related to maintaining ecosystem processes, functions, and health and is primarily useful in evaluating and formulating objectives that lead toward desired conditions. Quotations contain species-, location-, or time-specific details or quantify impacts.

Specific—Supports information needs at an operational level, including ecosystem process, habitat, and species-specific information and is useful in formulating design criteria that comply with objectives. Quotations contain species-, location-, or time-specific details and quantify impacts.

Effects—Highlighted quotations from scientific literature that describe the likely direct and indirect effects of climate change. Each effect is grouped by factor, category, region, and content resolution and is linked to source literature, supporting literature, and interacting factors (interactions).

Factors—Broadly defined subject areas that organize TACCIMO's content around themes significant to resource management with climate change impact implications.

Interactions—The influences of factors on each other in ways that may exacerbate or offset a given impact. Each factor in the TACCIMO system is linked to other factors that the literature suggests may interact.

Management Options—Quotations from scientific literature that describe practices of various scale intended to abate negative impacts and take advantage of opportunities where they exist. Each management option is grouped by factor, category, and region and is linked to source and supporting literature.

Region—A geographic reference describing the extent of application assigned to effects and management options.

Source Literature—The originator of the published research about effects and management options that are quoted directly from peer-reviewed scientific journal articles and synthesis reports.

Supporting Literature—Publication(s) about effects and management options that source literature quotes through in-text citations in support of its research. These citations extend the credibility of a given claim and point users to additional sources of more detailed or related information.

Decision-Supporting Process Connections

Professional natural resource managers and planners use a variety of decisionmaking frameworks across organizations and decision types. Decisionmaking frameworks are process driven and frequently require documented review of best available science. For Federal agencies, the science must be subject to a formal peer-review process to be considered (Office of Management and Budget 2002). A major strategic challenge that arises from the resulting widespread information demand is formulating and deploying technology transfer mechanisms that are compatible with multiple decision types and decisionmaking frameworks. A decision-support framework represents formal critical thinking (e.g., risk assessment) that involves assigning weights to evidence. The discussion in this section places TACCIMO in a generalized decision-support context (see app. C for additional examples).

General Decision Support—TACCIMO addresses information needs in a flexible manner that is not specific to any particular decisionmaking framework. Figure 2 depicts connections between TACCIMO and a generalized decision-support framework representing the critical stages and elements of decision-making (after Hammond and others 1999). TACCIMO contributes to the problem-structuring stage of the decision-support framework through intermediate literature and plan analysis processes:

Literature Analysis—The consideration of scientific knowledge is an essential input when properly defining or framing a management problem. This information is typically acquired, at least initially, through a literature review. It is important to note that weighting of individual pieces of evidence is done not by TACCIMO, but by the decisionmaker and the multiple participants of the decision-support process. For this reason, we term this critical thinking process a literature analysis rather than a review. The literature analysis is a more basic process that produces individual lines of evidence without any relative weight. TACCIMO literature and geospatial resources provide a starting point for this process, which when conducted properly provides an objective information basis, including identification of problem triggers, constraints, essential elements, dependencies, and scope (Hammond and others 1999). This objective information basis prepares the decisionmaker to effectively engage the public and local experts through a process that weighs the evidence within the broader context of the management decision, often using best professional judgment and other more qualitative methods (Linkov and others 2009).

Plan Review—Land management decisions are often conducted within the framework of a comprehensive plan, typically expressed in terms of vision, strategy, and criteria that apply to the management area or operational practice in question. TACCIMO planning resources prime the plan review process for Forest Service users in participating NFS regions by presenting potential science-planning relationships. In addition, planning information helps identify potential objectives and criteria. Clearly defined objectives and criteria are essential for identifying information needs, communicating with stakeholders, and weighting the importance of the decision (Hammond and others 1999).
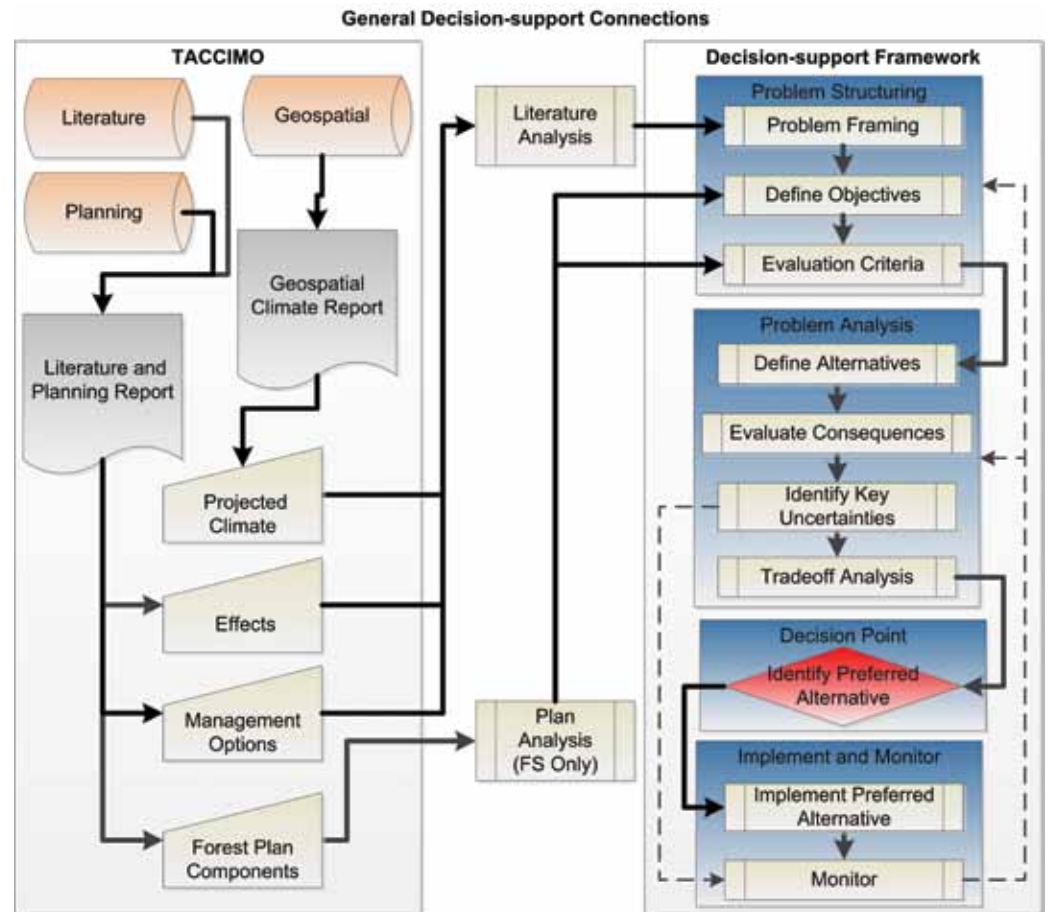

Figure 2—Flow diagram representing TACCIMO connections with a generalized decision-support framework (after Hammond and others [1999]).
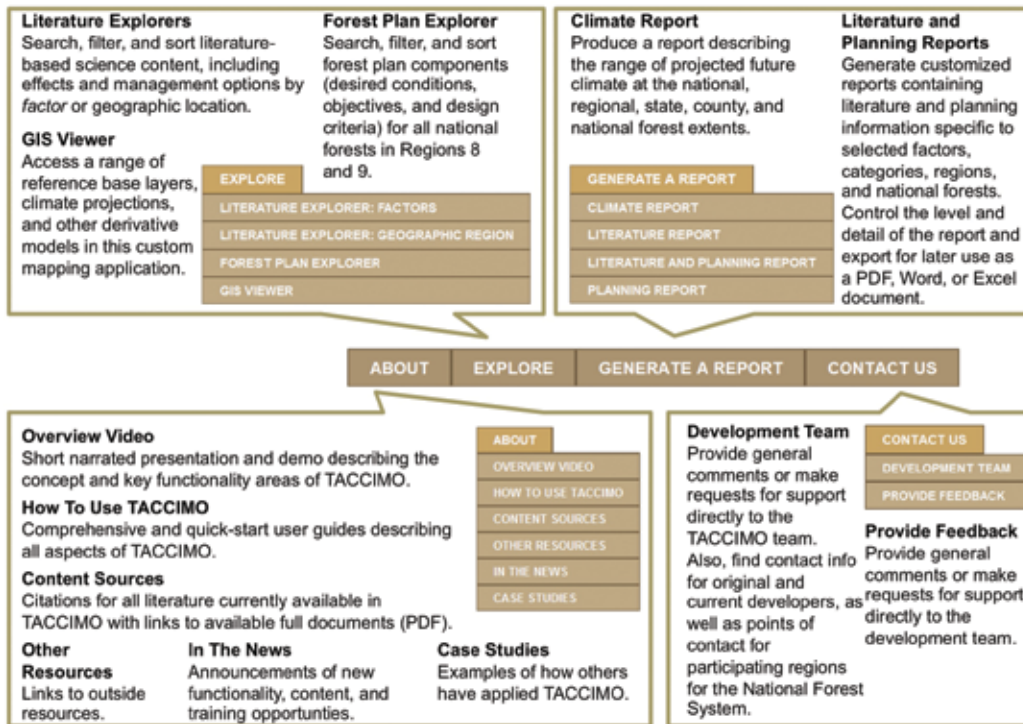
NAVIGATING AND USING TACCIMO

TACCIMO is a suite of Web-based tools that enable users to explore content and generate reports. Selecting the appropriate tool depends on the information and documentation requirement. Each navigation area is described in brief below (fig. 3) with detailed instructions for each tool in following sections. All tools and resources are available by visiting the following URL: http://www.forestthreats. org/taccimotool.

NOTE—The TACCIMO Web site is optimized for Microsoft Internet Explorer® version 6 or greater as viewed on a display with a minimum resolution of 800 by 600 pixels.

NAVIGATION TAB: ABOUT

The *About* interface provides users with supporting information, including training videos and instructional materials, overview of content sources, and links to other resources and case studies.

Overview Video—An orientation to TACCIMO use and navigation in less than 5 minutes and a good place for new users to start. Shorter and more detailed videos are also available for each of TACCIMO's specific tools.

How To Use TACCIMO—TACCIMO documentation, consisting of this user guide, quick start guides, and a list of all help videos and text. Every page that contains functionality is accompanied by four buttons for quick access to helpful information relevant to that part of TACCIMO (fig. 4).

Figure 3—Overview of TACCIMO navigation with general description for each navigation area utility.

Figure 4—Buttons that enable quick access to help text, a quick-start video, a feedback form, and a general disclaimer.

Content Sources—Catalog of available climate change literature:

Step 1—Hover over the *About* navigation dropdown menu. Select *Content Sources* (fig. 5: A).

Step 2—Search for a keyword or phrase in the full citation by entering text in the search field (fig. 5: B), then hit [Enter] or select *Contains* from the search dropdown. Filter records by lead author, journal, or publication date by selecting from the dropdown lists (fig. 5: C).

Step 3—To search for the full publication, select the *Search For Publication* link (fig. 5: D).

Step 4—Click the expand arrow to retrieve *Effect* and *Management Option* records obtained from the corresponding publication (fig. 5: E).

Other Resources—Links to relevant tools and information that are not directly used in TACCIMO.

In The News—Important announcements and events associated with TACCIMO, including training opportunities, TACCIMO appearances at meetings, and other newsworthy information.

Case Studies—Examples of how TACCIMO could be or has been applied to a variety of information needs ranging in complexity from forest plan revisions to self-education.

Figure 5—Screen capture of Content Sources page with key functionality elements indicated with arrows.

Figure 6—Screen capture of Literature Explorer: Factors page with key functionality elements indicated with arrows.

NAVIGATION TAB: EXPLORE

The *Explore* interface allows users to browse TACCIMO and become familiar with the type of information available and the organizational system in use.

NOTE: This interface does not track users' selections or generate reports.

Literature Explorer: Factors—Access to literature content organized around broad subject areas called factors.

> **Step 1**—Hover over the *Explore* navigation dropdown menu and select *Literature Explorer: Factors* (fig. 6: A).
>
> **Step 2**—Click the expand arrow (fig. 6: B) to view additional information about each *Factor*. There are five tabs nested under each *Factor*:
> - *Description* (fig. 6: C) contains a general overview of content within the *Factor*.
> - *Components* (fig. 6: D), *Categories* (fig. 6: E), and *Regions* (fig. 6: F) provide different content views:
>   - The *Components* tab is the most inclusive, both in content and functionality, and will be discussed in detail in subsequent steps.
>   - *Categories* and *Regions* summarize the subjects and geographic coverage found within each *Factor*. Selecting one of the links pre-filters the records based on the selection.
> - *Interacting Factors* (fig. 6: G) contains a list of other Factors cited to interact with the selected *Factor*.
>
> **Step 3**—Select the *Components* tab. There are four main content views under the *Components* tab:
> - *Effects* returns selected quotations describing effects of climate change and enables searching and filtering by keyword, *Category*, and *Region* (for more information, see step 4).
> - *Management Options* returns selected quotations describing abatement activities and enables searching and filtering by keyword, *Category*, and *Region* (for more information, see step 4).
> - *Content Sources* returns citations specific to the selected *Factor* (see instruction under *About, Content Sources* above).
> - *Supporting Literature* lists the complete citation for all parenthetically referenced literature contained within the *Factor*.
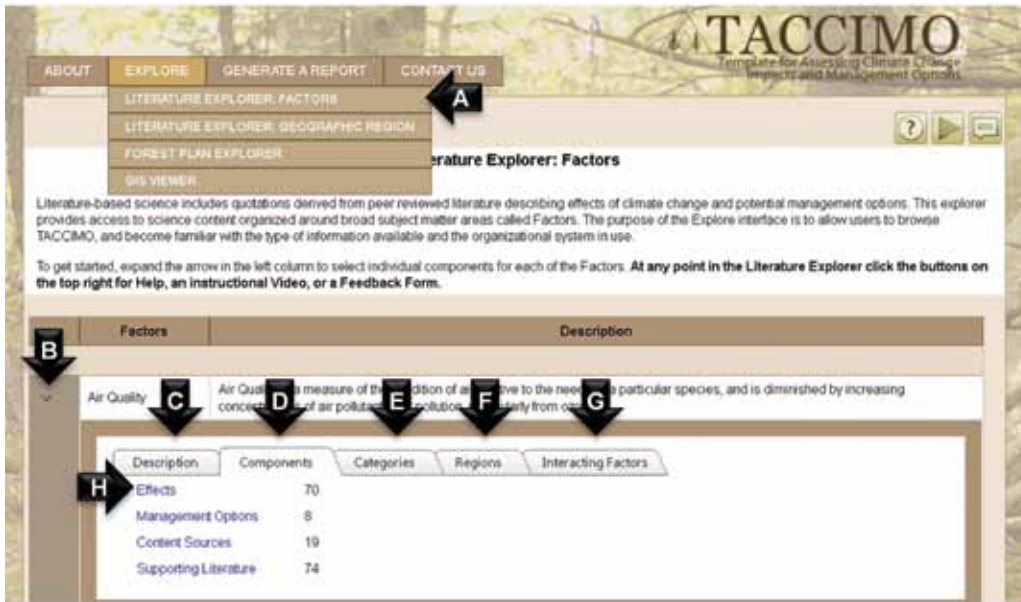
Step 4—Click the *Effects* link (fig. 6: H):
- Sort records by clicking on the column label (Fig. 7: A).
- Search for a keyword or phrase by entering text in the search field (fig. 7: B). Then hit [Enter] or select *Contains* from the search dropdown.
- Filter records by *Region* or *Category*, or both, by selecting the geographic area or subject of interest from the dropdown lists (fig. 7: C).
- View the source citation for each record by clicking the *Source* link (fig. 7: D).

Step 5—Click the expand arrow (fig. 7: E) associated with each *Effect* to view related *Management Options*, *Supporting Literature*, and *Interactions*. As with *Effects*, *Management Option* source citations are available by clicking the *Source* link (fig. 7: F). *Supporting Literature* and *Interactions* listed are specific to the selected *Effect* (fig. 7: G).

NOTE—Steps 4 and 5 use the *Effects* explorer to describe functionality found in the other *Explore* utilities. The *Management Options* explorer works exactly the same way but returns *Management Option* records as the top layer of content (with related *Effects* listed under the expanded view). Links found on the *Category* and *Region* tabs always begin with *Effects*, but provide different ways to pre-filter records.
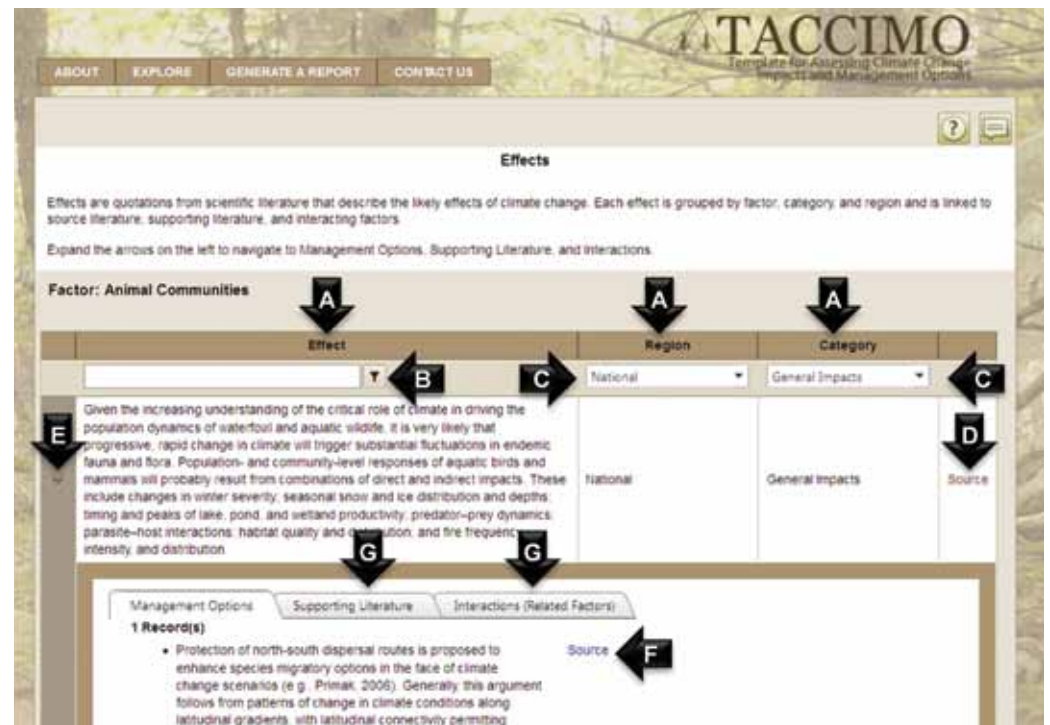

Figure 7—Screen capture of Literature Explorer: Factors page with key functionality elements indicated with arrows.

Figure 8—Screen capture of Literature Explorer: Geographic Region page with key functionality elements indicated with arrows.
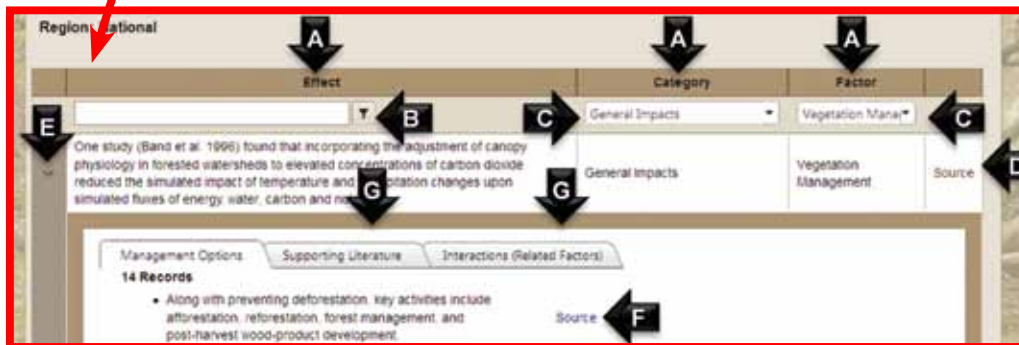
Figure 9—Screen capture of Literature Explorer: Geographic Region page with key functionality elements indicated with arrows.

Literature Explorer: Geographic Region—Access to science content derived from literature reviews and organized around hierarchical geographic regions.

Step 1—Under the *Explore* navigation dropdown menu select *Literature Explorer: Geographic Region* (fig. 8: A).

Step 2—Click on a *Region* name (fig. 8-B) to view records associated with that geographic area. Sort records by clicking on the column label (fig. 9: A). Search for a keyword or phrase by entering text in the search field (fig. 9: B), then hit [Enter] or select *Contains* from the search dropdown. Filter records by *Category* or *Factor*, or both, by selecting the subject of interest from the dropdown lists (fig. 9: C). View the source citation for each record by clicking the *Source* link (fig. 9: D).

Step 3—Click the expand arrow (fig. 9: E) associated with each *Effect* to view related *Management Options, Supporting Literature*, and *Interactions*. As with *Effects, Management Option* source citations are available by clicking the *Source* link (fig. 9: F). *Supporting Literature* and *Interactions* listed are specific to the selected *Effect* (fig. 9: G).

Forest Plan Explorer—Access to land and resource management plan components for participating regions of the Forest Service.

    Step 1—Under the *Explore* navigation dropdown menu select *Forest Plan Explorer* (fig. 10: A).

    Step 2—Click a national forest name (date of latest plan version is indicated in parentheses) to view associated records (fig. 10: B).

    Step 3—Click on each tab to view the different components (fig. 11: A). Sort records by clicking on the column label (fig. 11: B). Search for a keyword or phrase by entering text in the search field (fig. 11: C), then hit [Enter] or select *Contains* from the search dropdown. Filter records by plan *Heading* or related literature *Factor*, or both, by selecting the subject of interest from the dropdown lists (fig. 11: D).

Figure 10—Screen capture of Forest Plan Explorer page with key functionality elements indicated with arrows.

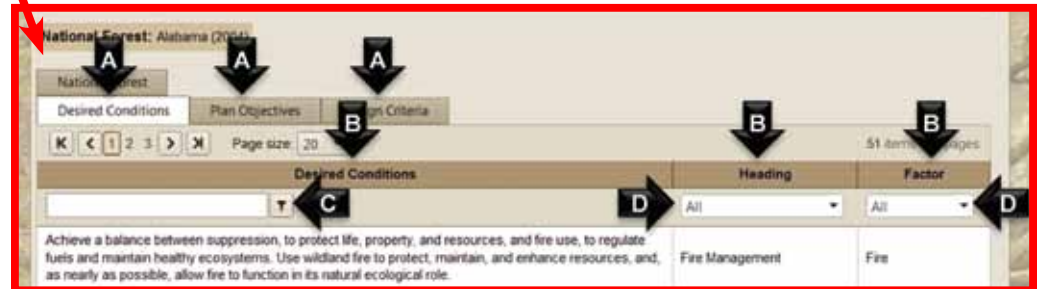**Figure 11—Screen capture of Forest Plan Explorer page with key functionality elements indicated with arrows.**
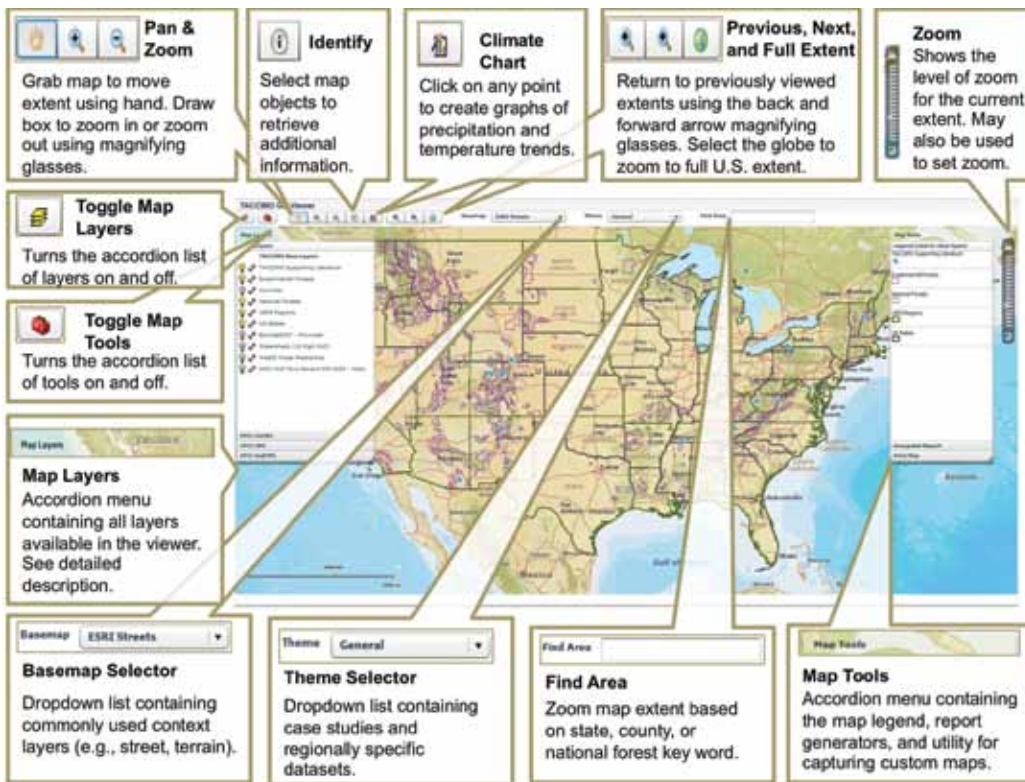
Pan & Zoom
Grab map to move extent using hand. Draw box to zoom in or zoom out using magnifying glasses.

Identify
Select map objects to retrieve additional information.

Climate Chart
Click on any point to create graphs of precipitation and temperature trends.

Previous, Next, and Full Extent
Return to previously viewed extents using the back and forward arrow magnifying glasses. Select the globe to zoom to full U.S. extent.

Zoom
Shows the level of zoom for the current extent. May also be used to set zoom.

Toggle Map Layers
Turns the accordion list of layers on and off.

Toggle Map Tools
Turns the accordion list of tools on and off.

Map Layers
Accordion menu containing all layers available in the viewer. See detailed description.

Basemap Selector
Dropdown list containing commonly used context layers (e.g., street, terrain).

Theme Selector
Dropdown list containing case studies and regionally specific datasets.

Find Area
Zoom map extent based on state, county, or national forest key word.

Map Tools
Accordion menu containing the map legend, report generators, and utility for capturing custom maps.

Figure 12—Overview of GIS Viewer layout, navigation, and utilities.

GIS Viewer—Interactive access to climate change projections, derivative models, and natural resource context layers. Figure 12 shows the layout of the *GIS Viewer*, including the menu bar along the top and the *Map Layers* and *Map Tools* accordions, which are described in more detail in subsequent sections.

Map Layers: Selecting Layers and Setting Layer Properties—The *Map Layers* accordion (fig. 13) contains all of the layers available for viewing:

- *Selecting Layers*—*Map Layer* accordions expand, revealing the layers contained within when the accordion's name (e.g., *Base Layers*) is selected. Map layers are displayed on the map in the order they are listed in the accordion (layers at the top are drawn on top of layers at the bottom).

- *Layer Properties*—*Map Layer* accordions contain multiple map layers that may be turned on or off by selecting the corresponding light bulb. As such, it may be necessary to make opaque layers translucent by using the *Layer Properties* utility. The *Layer Properties* utility also contains the option for layer data to be returned in *Identify* queries (default is to include layer in *Identify* results).
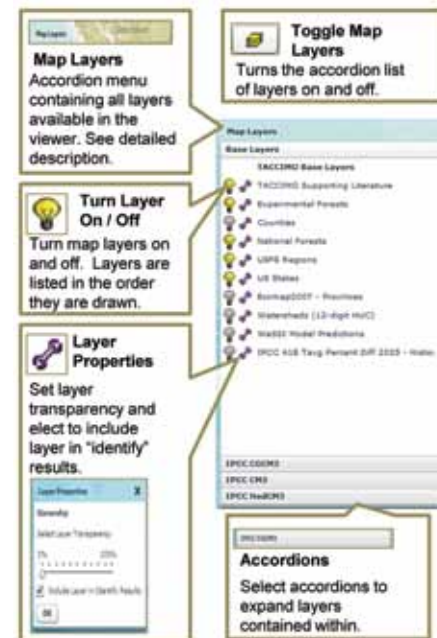

Map Layers
Accordion menu containing all layers available in the viewer. See detailed description.

Turn Layer On / Off
Turn map layers on and off. Layers are listed in the order they are drawn.

Layer Properties
Set layer transparency and elect to include layer in "identify" results.

Toggle Map Layers
Turns the accordion list of layers on and off.

Accordions
Select accordions to expand layers contained within.

Figure 13—Overview of GIS Viewer Map Layers accordion.

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Map Tools: Legend, Climate Report, and Print Tools—The *Map Tools* accordion (fig. 14) contains the *Legend, Climate Report Generator,* and *Print Map* utility:

• *Legend*—The maps *Legend* is the top accordion in *Map Tools.* The *Legend* contains key information about layers currently selected and displayed on the map. Layers turned on can be cleared (turned off) by clicking on them. To turn a layer back on, click on the light bulb next to the layer.

• *Climate Report*—Considering differences among GCMs and Intergovernmental Panel on Climate Change (IPCC) emissions scenarios is challenging but critical to understanding the full range of potential future climate anticipated for a given location. The full range of potential future climate is represented by different combinations of GCMs and scenarios depending on the scale, location, and variable (precipitation or temperature). Although most or all of the climate data available through the TACCIMO *GIS Viewer* can be summarized in tables and graphs, maps are better at depicting spatial variability. The *Climate Report* function will generate a standard report describing national, regional, and location-specific (State, county, or national forest) trends and boundaries in projected climate.
  • To produce a climate report, enter a State, county, or national forest name in the text box and select *Run Report.* A couple of important items to be aware of when generating geospatial reports are:
  1. It may take several minutes to run the report, depending on the number of other users accessing the system; and
  2. The report explains the content, so the explanation is not repeated in this user guide.

• *Print Map*—Because the *Climate Report* generates a standard set of maps, it may be necessary to capture custom maps as viewed in the map window. This feature allows for capture of content not available in the *Climate Report.* Examples include custom maps containing specific context layers as well as other model data (e.g., Water Supply Stress Index) not available in the standard report. To produce a custom map:
  1. Set the map view to the area of interest.
  2. Select layers of interest and set transparency as needed.

3. In the *Print Map* accordion:
  a. Select the desired page orientation (Landscape or Portrait).
  b. Provide a map title.
4. Select the *Set Map Size* button to preview the extent of the map as it will appear when exported.
5. Select the *Export Map* button to complete the exporting process. It may be necessary to select the *Restore Map* button to return map window to original size.

• *Export Map to JPG*—The map view and legend may also be exported directly as a JPG image by using the *Export Map to JPG* utility located beneath the *Print Map* utility. Select *Export Map* or *Export Legend* and then click the *Export* button, which will prompt you to open or save.

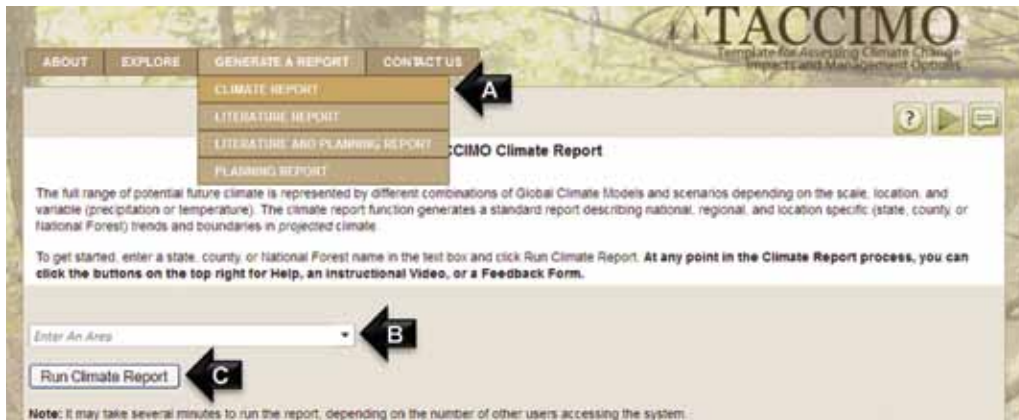**Figure 14—Overview of GIS Viewer Map Tools accordion.**

Figure 15—Screen capture of Climate Report page with key functionality elements indicated with arrows.

Figure 16—Screen capture of Literature Report page with key functionality elements indicated with arrows.

NAVIGATION TAB: GENERATE A REPORT

The *Generate A Report* interface allows users to document and export content found in TACCIMO in preferred formats. The report interface parallels the *Explore* interface and enables quick summarization of information to help guide additional analysis and expert consultation.

Climate Report—A PDF report outlining the full range of potential future climate represented by different combinations of GCMs and scenarios. The *Climate Report* function will generate a standard report that describes national, regional, and location-specific (State, county, or national forest) trends and boundaries in climate.

> **Step 1**—Hover over the *Generate A Report* navigation dropdown menu and select *Climate Report* (fig. 15: A).
>
> **Step 2**—Enter a State, county, or national forest name in the text box (fig. 15: B) and click *Run Report* (fig. 15: C). A couple of items to be aware of when generating climate reports are:
> - It may take several minutes to run the report, depending on the number of other users accessing the system.
> - The report explains the content, so the explanation is not repeated in this user guide.

Literature Report—An exportable report from the science literature content based on a series of user-defined selections. The objective is to quickly and efficiently capture a logically organized snapshot of content in TACCIMO specific to a resource management area and geographic location.

> **Step 1**—Hover over the *Generate a Report* navigation dropdown menu and select *Literature Report* (fig. 16: A).
>
> **Step 2**—Select one or more general subjects of interest from the *Select Factors* dropdown menu (fig. 16: B) that are relevant to the management activity or information need.
>
> **Step 3**—Select one or more specific subjects from the *Select Categories* dropdown menu (fig. 16: C). *Categories* listed are populated based on *Factors* selected in the previous step.

Step 4—Select one or more geographic areas from the *Select Region* dropdown menu (fig. 16: D). TACCIMO *Regions* reflect a hierarchical organization system (described previously), and it is appropriate in most cases to select more than one *Region* to capture all of the content relevant to a location. The "National" *Region* is selected by default.

Step 5—Select one or more levels of detail from the *Select Resolutions* dropdown menu (fig. 16: E). Content Resolution enables users to control the amount of detail provided in the report at three different levels (general, moderate, specific). All three levels are selected by default.

Step 6—Click the *Run Report* button (fig. 16: F) to preview the report content and organization in the frame below the report controls. Use the report controls to navigate through the report preview and export it by selecting from the *Format* dropdown menu and then clicking the *Export* link (fig. 16: G).

Literature and Planning Report—An exportable report from the science literature and planning content based on a series of user-defined selections. The objective is to quickly and efficiently capture a logically organized snapshot of content in TACCIMO specific to a resource management area and geographic location.

NOTE—Steps 2-5 are the same as for the stand-alone *Literature Report* described in the previous section. Only the modified and additional steps are included.

Step 1—Hover over the *Generate a Report* navigation dropdown menu and select *Literature and Planning Report* (fig. 17: A).

Steps 2-5—Follow steps 2-5 for *Literature Report* above (fig. 17: B-E).

Step 6—Select one or more forest plans from the Select *National Forest* dropdown menu (fig. 17: F).

Step 7—Click the *Run Report* button (fig. 17: G) to preview the report content and organization in the frame below the report controls. Use the report controls to navigate through the *Report Preview* and export it by selecting from the *Format* dropdown menu and then clicking the *Export* link (fig. 17: H).

Figure 17—Screen capture of Literature and Planning Report page with key functionality elements indicated with arrow.

Figure 18—Screen capture of Planning Report page with key functionality elements indicated with arrows.

Planning Report—An exportable report for NFS planning content based on a series of user-defined selections. The objective is to provide a quick reference guide with forest planning language independent of TACCIMO factors.

    Step 1—Hover over the *Generate a Report* navigation dropdown menu and select *Planning Report* (fig. 18: A).

    Step 2—Select one or more forest plans from the *National Forest* dropdown menu (fig. 18: B).

    Step 3—Include one or more forest plan component types by clicking the corresponding button (fig. 18: C).

    Step 4—Click the *Run Report* button (fig. 18: D) to preview the report content and organization in the frame below the report controls. Use the report controls to navigate through the report preview and export it by selecting from the *Format* dropdown menu and then clicking the *Export* link (fig. 18: E).

NAVIGATION TAB: CONTACT US

The *Contact Us* area provides users with mechanisms for giving feedback and obtaining support.

Provide Feedback—A feedback form allows users to provide information about themselves, site functionality, and site content.

Development Team—Contact information is listed for key TACCIMO team members for providing direct feedback to TACCIMO leadership and support staff.

EXPLORE AND REPORT OUTPUTS

The inputs described in detail in the previous section are compiled in *Explore* and *Report* modules, providing users with both flexible and structured access options. The placement of content elements in each module offers a spectrum of organization that reinforces the underlying science-management integration objectives of TACCIMO. In addition, the output products are designed to complement each other and the external decision-support process (fig. 19). This section describes placement of content elements in outputs but does not describe content production methods, element definitions, or functionality descriptions (refer to the previous section and to app. C).

Explore

The *Explore* modules provide Web-based access to the TACCIMO information framework. The user's experience is intended to be intuitive, relying on hierarchical content organization to navigate content based on familiar subject matter and geographic designations. The *Explore* interface is typically used for becoming familiar with content, leading to report generation. However, the *Explore* modules may be revisited after a report is generated to focus on specific content through their unique word search function.

Literature Explorer—The two *Literature Explorer* applications display content organized by subject (factors) and by geographic extent (region). Both explorers are based on the same underlying elements but differ in the initial content organization. The *Factors Explorer* displays all of the content within a single factor, allowing for interactive filtering by selected combinations of category, region, or user-defined words. The *Regions Explorer* displays all of the effects within a single region, allowing for interactive filtering by selected combinations of factor, category, or user-defined words (fig. 19).

> *About: Content Sources*—The *Content Sources* application under the *About* navigation dropdown (also depicted in fig. 5) contains complementary capabilities specific to source literature citations, including the ability to retrieve original journal articles through Google Scholar™ and view effects or management options from a particular source.

Forest Plan Explorer—The *Forest Plan Explorer* application displays forest plan content organized by national forest. Once a national forest of interest is selected, users can filter components by plan heading, related literature factor, and user-defined words (fig. 19).

GIS Viewer—The *GIS Viewer* application displays climate data and derivative models with relevant natural resource context layers. Theme and map layer selections made by the user determine the content available for display and what is drawn on the map, respectively. Custom maps can be captured for use in external products through *Print* and *Export* features (fig. 19).
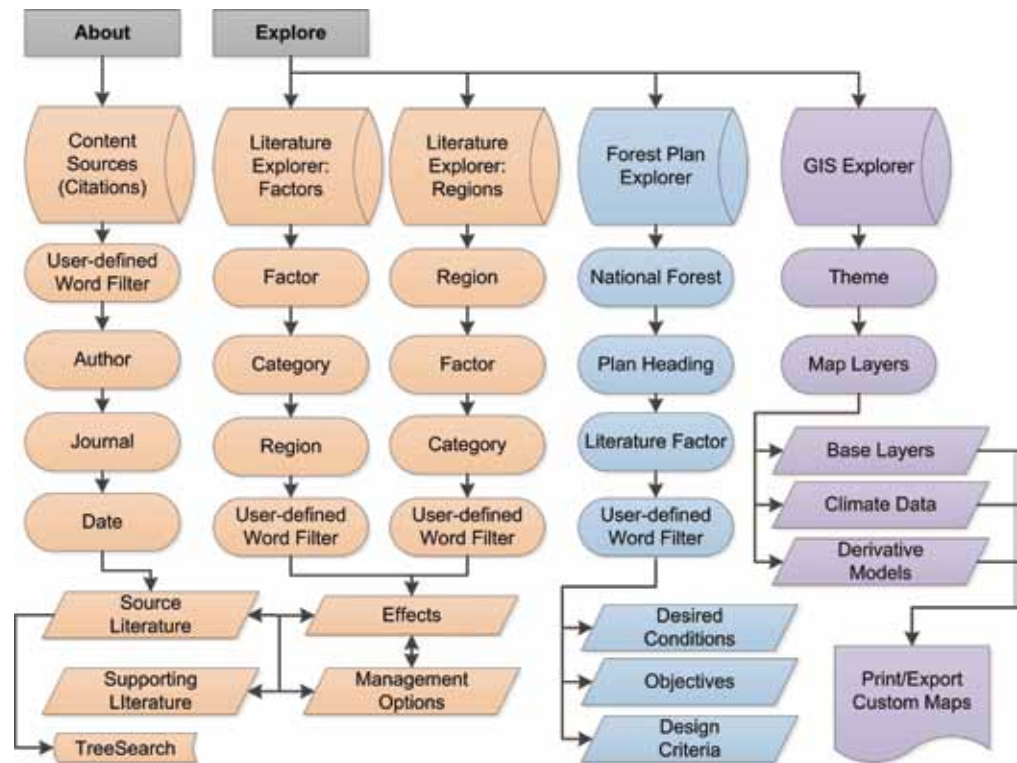

Figure 19—Simplified flow diagram representing the structure and placement of content elements within Explore modules.
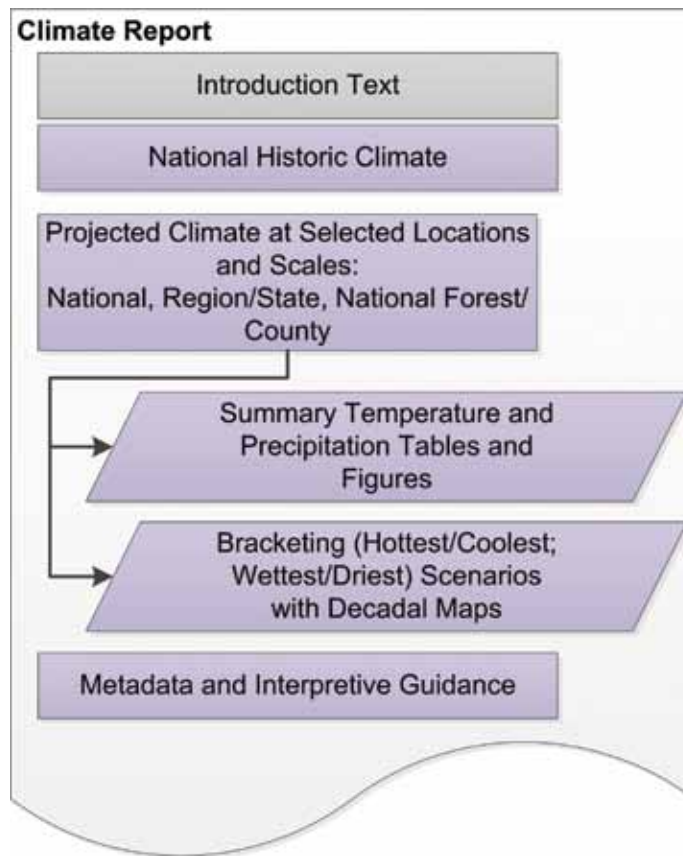
Figure 20—Diagram depicting the organization layout and placement of content elements within the Climate Report.

Reports

The *Report* modules capture inputs as structured and exportable documents that are readily transferable to support external review. The reports represent a snapshot of TACCIMO content at the time of the user's interaction and can be compared with future reports and *Explore* interactions.

Climate Report—The *Climate Report* generator application identifies the range of projected future climate. The report is structured around geographic and temporal extents (fig. 20). The report contains a cover page with introductory text describing the intent of the report and the sources of presented data. An overview of national historic climate is provided, followed by projected climate repeated across telescoping geographic scales. Depending on the location selected, the report will present a time series for national (conterminous United States), regional (Forest Service), and national forest, or national, State, and county geographic scales. Each projected climate section presents temperature and precipitation in tables, figures, and maps with numerical summaries bracketing the hottest/coolest and wettest/driest projections available. The report concludes with metadata and interpretive guidance.

Literature Report—The *Literature Report* generator application builds a standardized exportable report from the science literature content. The report output is prefaced with brief interpretive guidance and a summary of the user's selections. The report follows a nested structure beginning with Factors (including a brief abstract) as the most general level of organization (fig. 21). Denoted by indentation, the organizational subsections begin with Categories, followed by Regions, and then Content Resolution. The paired effects and management options are the primary report content. Each effect and management option is accompanied by a numerical reference to the source literature citation listed at the end of the report. Any supporting literature parenthetically cited is also referenced at the end of the report in the Supporting Literature section.

Literature and Planning Report—The *Literature and Planning Report* generator builds on the previously described *Literature Report* by including related forest plan content. The *Planning Report* is included at the end of the *Literature Report* and follows a similar nested structure. It begins with the *Related Literature* factor followed by indented subsections that list the national forest name, then the plan heading (fig. 21). Each plan component (*Desired Condition, Objective,* and *Design Criteria*) is provided as a separate section repeating this structure.

Planning Report—The *Planning Report* generator builds a stand-alone report from the planning content following the same structure found in the *Literature and Planning Report* description above (fig. 21). The key difference is that the content returned is not restricted to planning content related to selected literature factor(s).
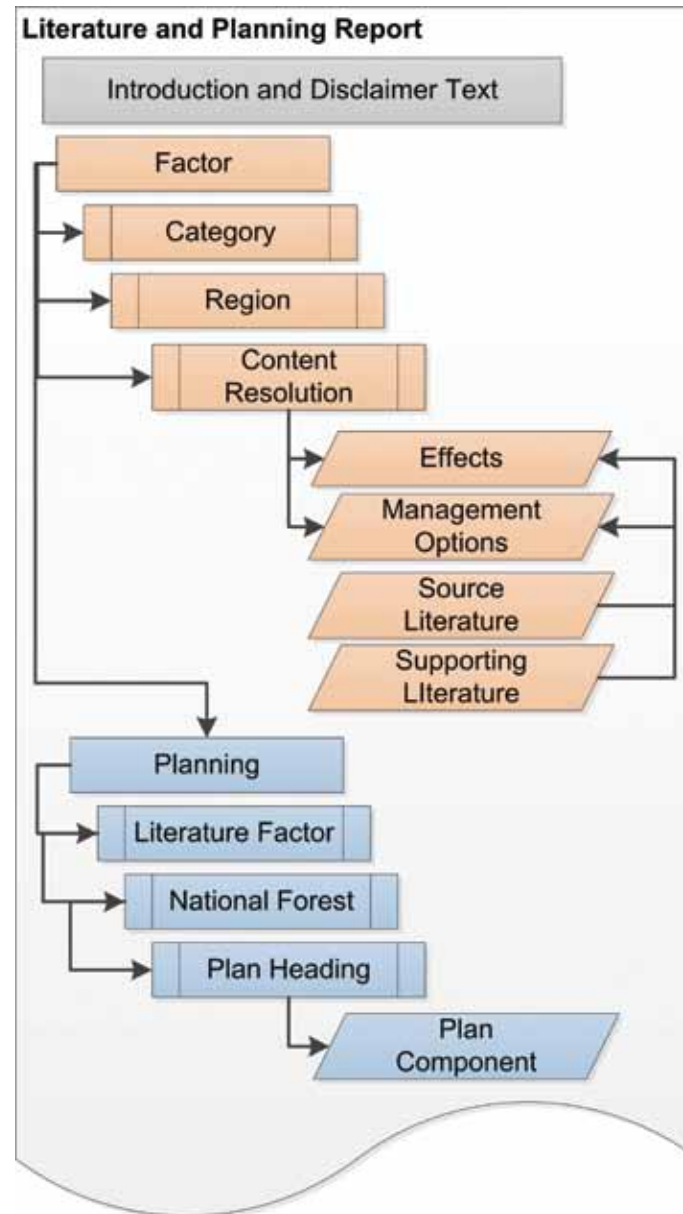

Figure 21—Diagram depicting nested organizational layout and relative content element placement of the Literature and Planning Report.

PURPOSE AND TERMS OF USE

General Purpose

The ongoing goals of TACCIMO are to:

- Provide an efficient, dynamic, and value-added set of Web-based tools, information, and services designed to support the climate change information needs of professional natural resource managers and planners, and the public.

- Provide resources that are simple, easy to use, and flexible enough to support a range of planning and management disciplines across scales and decision-support frameworks.

- Provide a point of initiation in the climate change thought process leading to and supporting additional analysis and expert consultation within a broader science assessment framework.

Terms of Use

Users must understand the intended uses and limitations of TACCIMO products. The following terms of use apply to all TACCIMO content and products:

- It is the responsibility of the user to read this user guide, including sections guiding appropriate interpretation of results (this section), and the content production section (app. B), which explains how content found in TACCIMO is developed.

- TACCIMO provides information to support the initial phase of a more comprehensive and rigorous evaluation of climate change within a science assessment framework. It is the responsibility of the user to conduct further analysis (including review of primary sources) and consultation with experts when evaluating TACCIMO results. The exact form of this process will vary with the scale and nature of the planning or management activity in question, but TACCIMO is an initial step in a more involved decision-support process and not a substitute for it.

- TACCIMO is not all-inclusive nor is it fully developed for all geographic regions or natural resource management subjects.

- The content produced for TACCIMO is developed from sources of differing accuracy, based on modeling or interpretation, and appropriate only at certain scales. TACCIMO cannot guarantee the accuracy, completeness, reliability, or suitability of this information for any particular purpose. Using data for purposes other than those for which they were created may yield inaccurate or misleading results. TACCIMO is not liable for any activity involving this information with respect to losses or damages.

ACKNOWLEDGMENTS

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APPENDIX A:
STRATEGIC CONTEXT

In a broad-scale effort to build decision-support capacity with respect to climate change, Forest Service (FS) management goals and strategic initiatives call for improved technology transfer capabilities. TACCIMO aligns with these initiatives, including the *Forest Service Strategic Framework for Responding to Climate Change* (USDA Forest Service 2008a), the *National Roadmap for Responding to Climate Change* (USDA Forest Service 2011b), the *Climate Change Performance Scorecard* (USDA Forest Service 2011a), and the *National Forest System Land Management Planning (Final Rule and Record of Decision)* (USDA Forest Service 2012b).

Forest Service Strategic Framework for Responding to Climate Change (USDA Forest Service 2008a)—The *Framework* is composed of seven areas: science, adaptation, mitigation, policy, sustainable operations, education, and alliances. Central to TACCIMO's goal is *Framework* Action 1.1, which specifies a need for "mechanisms to ensure a systemic, interactive dialogue between researchers, public and private land and resource managers, and other users to promote effective climate change science delivery" (USDA Forest Service 2008a: 14). TACCIMO addresses other identified actions to varying degrees, such as:

> *Action 1.3*—Enhanced methods for moving science into application.
> *Action 2.3*—Assessments and syntheses that will help guide land management actions.
> *Action 4.3*—Integrate climate change into agency direction, including forest planning.
> *Action 6.3*—Science findings and products, that are easily available, for a diverse set of audiences.

National Roadmap for Responding to Climate Change (USDA Forest Service 2011b) and Climate Change Performance Scorecard (USDA Forest Service 2011a)—Acting as the implementation plan for the *Framework*, the *National Roadmap* is guiding responses to climate change at multiple operational scales across the National Forest System. The *Performance Scorecard* tracks implementation of the *Roadmap*. TACCIMO most directly supports the science-management integration element of the *Scorecard's* engagement dimension, but also contributes to organizational capacity (employee education and training) and adaptation (vulnerability assessment, adaptation activities, and monitoring) dimensions.

APPENDIX B:
CONTENT PRODUCTION SYSTEM

The content production system works to capture information in an efficient, timely manner and ensure the availability and creditability of information across content types within the TACCIMO framework. The production methods for information in each content area are discussed in subsequent sections, including descriptions of the content elements, organization, development, metadata, and review and maintenance protocols.

Science: Literature

Literature-based science includes quotations derived from peer-reviewed literature that describe effects of climate change and potential management options. Table B.1 provides a brief overview of the data elements that constitute TACCIMO's literature content, as well as their relative roles. Each element and role are defined in greater detail in subsequent sections.

Content Organization—The information framework developed for TACCIMO is based on the need to capture and organize scientific information about climate change in a way that is meaningful and relevant to forest planning and management. Content is organized into subject matter areas and geographic regions:

Factors and Categories—TACCIMO is organized into a flexible framework of subject matter areas consisting of broad factors and more specific categories. Factors capture the overarching direct and indirect effects of climate change on natural resources. Categories are assigned within factors to promote efficient organization and navigation of primary records. This structure is fundamental to the functionality of TACCIMO and enables automated relationship-building between management options and effects. To allow flexibility in capturing an ever-evolving issue, new factors and categories may be added to the TACCIMO organizational structure.

Regions—TACCIMO regions are hierarchical and designed to organize content with respect to geographic extent (figs. B.1 and B.2). The intent of this approach is to capture and preserve information at appropriate scales of application. In general, Forest Service (FS) administrative regions are preserved, but reconciling differences in scale required the introduction of domains (east and west) and subregions for the Eastern United States.

Table B.1—Literature elements defined and organized by role

| Role	Element
Factors: General grouping (typically resource areas) used to organize content. Category: More specific subject-based organization within factors. Region: A hierarchical geographic reference representing applicable extent of information.	Organization
Effects: Quotations describing ecosystem impacts and responses. Management options: Quotations describing practices to adapt to, resist, or take advantage of opportunities.	Primary
Source literature: The primary-source journal articles from which primary records are quoted. Supporting literature: The in-text parenthetical citations referenced by source literature. Content resolution: Qualitative descriptor assigned to a quotation that captures its level of detail. Interactions: Tracking mechanism to capture linkages among factors.	Metadata
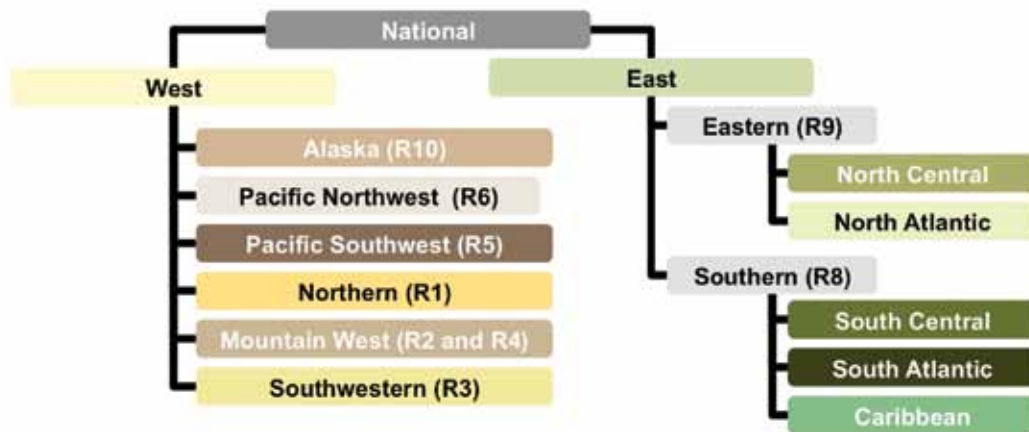
Figure B.1—Diagram depicting hierarchical regions.
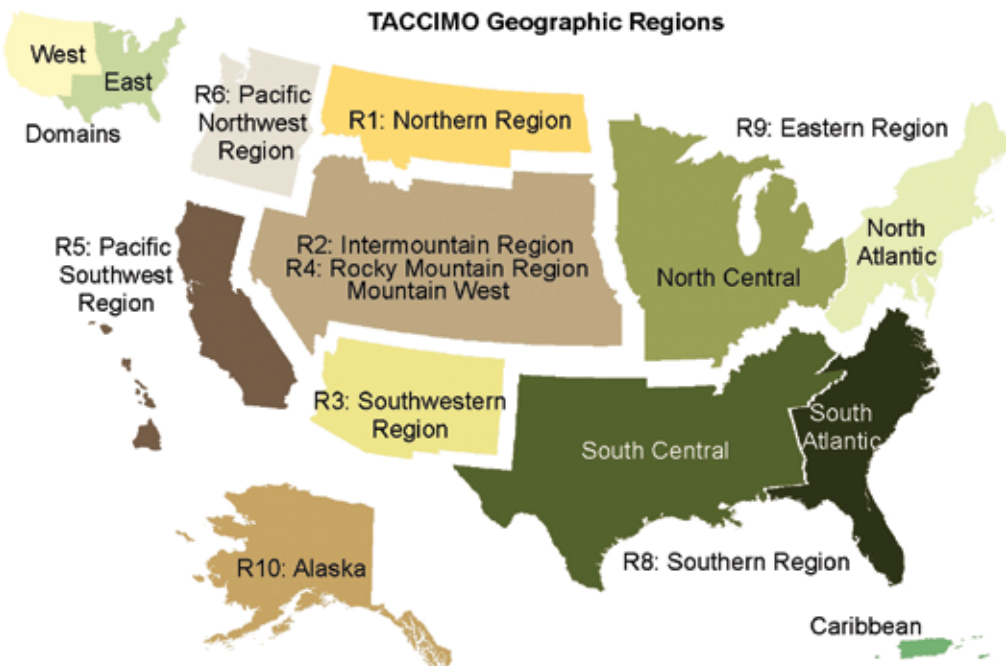
Figure B.2—Map depicting geographic extent of domains, regions, and subregions.

Content Development Approach—National climate assessment products (e.g., U.S. Global Change Research Program Synthesis and Assessment products) are used as cornerstone documents, identifying key issues and sources of more detailed information. The process involves following the "information network" from these broad assessments down to primary source science. Additional data-gathering techniques (e.g., user-requested searches and literature alerts) help prioritize and capture the most recent and relevant climate change science.

Content Criteria—The selection of quotations for inclusion in TACCIMO is based on a standardized literature review process. The goal is to highlight key findings related to land management and planning. The quotations included are those that would likely be highlighted for further consideration in a traditional literature review process. Quotations, rather than paraphrases, are provided to:
(1) reduce subjectivity,
(2) allow for additional relationship building (e.g., effects-management options-planning),
(3) allow for literal linkages back to primary sources and supporting literature, and
(4) allow for inclusion of more specific information than paraphrasing efficiently permits.

Careful consideration is given to the context from which quotations are taken, but quotation by its very nature requires application of judgment and results in loss of context. To abate the loss of context to the greatest extent possible and promote the highest level of data quality, the following criteria are strictly applied:
- Literature is peer reviewed, either as stated by the publishing journal's guidelines, explicitly within the paper, or by personal contact with the author.
- The subject and theme of the quotation are consistent with the subject and theme of the source as a whole.
- The conclusion of the selected quotation is clearly substantiated by the scientific evidence reported in the source article and cited supporting literature.
- If the claim is based on synthesis, supporting literature citations substantiate the synthesized conclusion.
- The length of the quotation is kept to the minimum length sufficient for understanding the statement independently of accompanying text.
- Qualifying statements and statements addressing uncertainty are included.

Metadata—The metadata accompanying each quotation serve one of two roles: (1) to track source and supporting literature, or (2) to enhance detection of relationships among elements (effects and management options).

Source Literature—Primary records are quoted from source documents, and the citations are tracked to readily connect users with the original documents for further evaluation (APA 2009).

Supporting Literature—Primary records often contain parenthetical references in or near the selected quotation. These citations are tracked to further substantiate the claim of the quotation and help connect users with additional information that may or may not be included in TACCIMO. Supporting Literature does not have to be peer reviewed, which allows users to find potentially relevant resources in the body of white and gray literature.

Interactions—Quotations often explicitly refer to more than one subject matter area (i.e., factor). Each quotation must be classified into only one factor, and the interactions' metadata permit tracking of related factors that a given quotation explicitly references. Interactions at the quotation level are summarized at the factor level to emphasize to users the potential for compounding impacts and are sometimes grouped into a common category across factors (i.e., interactions with other factors).

Content Resolution—This construct seeks to capture the level of detail expressed in a quotation. Content Resolution supports the relationship-building process between effects and management options and allows users to select the suitable level of detail for their application within the reporting output:

- General detail is captured for use during strategic planning but typically lacks actionable information and is primarily useful in evaluating and formulating desired conditions.

- Moderately specific detail is captured to support information needs related to maintaining ecosystem processes, functions, and health and is primarily useful in evaluating and formulating objectives that lead toward desired conditions. Quotations contain species-, location-, or time-specific details or give a numerical quantification.

- Specific detail is captured to support information needs at an operational level, including ecosystem process-, habitat-, and species-specific information and is useful in formulating design criteria that comply with objectives. Quotations contain species-, location-, or time-specific details and give a numerical quantification.

Review and Maintenance—The literature content is subject to both continuous and episodic forms of review and maintenance. The process is summarized in four discrete steps, but in practice some steps occur in parallel.

Primary Literature Review—The primary literature review follows the guidelines described in previous sections pertaining to content organization, development approach, criteria, and metadata. Multiple content contributors use this same approach.

Data Entry—Data entry is carried out through a content management system with procedures that ensure all necessary information is captured. These procedures are used by multiple content contributors.

Preproduction Review—A quality-control review of new content is conducted before release to ensure that literature review and data entry were implemented correctly. This quality-control process is done by the content manager.

Ongoing User Review—After the content goes into production, users provide feedback on the utility, applicability, and correctness of available information through built-in feedback forms. The content manager uses this information to refine existing content and guide future content development.

Content Guidance—The following general guidelines apply to the literature content available from TACCIMO:

Purpose—The literature inventory and highlighted quotations describing climate change effects and management options available through TACCIMO are included to help users initially identify climate change implications for planning and management tasks at a variety of scales. This information is sourced from peer-reviewed scientific literature following defined methodology and criteria.

Strengths—The primary elements of TACCIMO's literature-based science are quotations organized into a dynamic and interactive information framework. This approach allows for rapid creation and for efficient access to a wide variety of subject matter.

Limitations—Quotations included in TACCIMO, though developed following defined methods and criteria, do not provide the full richness of contextual information that accompanies them in their primary source. Users are responsible for reviewing the full text of any sources found to have significant implications for the management or planning situation in question.

Science: Geospatial—Projections and Models

Geospatial-based science includes downscaled climate projections, historic climate data, natural resource context layers (e.g., forest and watershed boundaries), and other spatially explicit models relevant to natural resource decisionmaking. Climate projections form the primary spatial content; derivative models provide insight into the effects of climate change on key resource

characteristics. Climate projections are included to provide bounds around the range of climate change forecasts. Derivative models consider climate change impacts on ecosystem services such as carbon, species diversity, and water resources.

Content Organization—Geospatial content is selected and organized to provide context for considering TACCIMO's climate change literature-based science and planning outputs. In particular, the climate forecasts and models are intended to set bounds around the likely range of projected climate change. Documenting the magnitude and direction of change will assist users in identifying effects of greatest concern for a given location and time. TACCIMO places location-specific trends in the context of regional and national trends to provide a better perspective on climate change across broader scales. The global climate models (GCMs) included in TACCIMO were selected from the catalog of downscaled Intergovernmental Panel on Climate Change (IPCC) GCMs and Special Report on Emissions Scenarios (SRES) emissions scenarios compiled by the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3) (tables B.2, B.3, and B.4; fig. B.3).

Table B.2—Summary of modeling groups, global climate models (GCM), and qualitative descriptions

Modeling Group	GCM	Description
Canadian Centre for Climate Modeling & Analysis	CGCM3.1	Wet and cool
Hadley Centre for Climate Prediction and Research/Met Office	HadCM3	Hot
U.S. Department of Commerce/National Oceanic and Atmospheric Administration/Geophysical Fluid Dynamics Laboratory	CM2.1	Dry and warm

Table B.3—Summary of Intergovernmental Panel on Climate Change (IPCC) scenarios, emissions paths, and descriptions

Scenario	Emissions path	Description
SRES A2	"higher"	Technological change and economic growth more fragmented; slower, higher population growth
SRES A1B	"middle"	Technological change in the energy system is balanced across all fossil and non-fossil energy sources, where balanced is defined as not relying too heavily on one particular energy source
SRES B1	"lower"	Rapid change in economic structures toward service and information, with emphasis on clean, sustainable technology; reduced material intensity and improved social equity

SRES = Special Report on Emissions Scenarios.

Derivative models use climate projections as inputs to provide insight into the impacts of climate change on key resource characteristics. Examples are nitrogen deposition (McNulty and others 2007), water supply (Sun and others 2008), and shifts in species distributions (Prasad and others 2007-ongoing). Key input and output layers are included in the GIS Viewer. Inputs and outputs can be included in custom maps created with the GIS Viewer. Links back to the model creator, and any enhanced version of the model, are provided.

Content Development—Developing the projections and models content involves acquiring, processing, and publishing all data layers in a consistent geospatial format. All data are served as ESRI ArcGIS version 10.01 geodatabases, and metadata references for all data are available in the GIS Viewer Metadata documents. All GCM content was selected from the official IPCC Fourth Assessment Report (AR4) to insure the most recent and credible projections. Criteria for publishing other, derivative models include the peer review of model methods and outputs and proven application for natural resource management related to climate change.

Table B.4—Comparison of average, minimum, maximum, and standard deviation for precipitation and temperature variables over two time periods between TACCIMO and Climate Wizard comprehensive offerings

	Precipitation (mm/year)							
	2040-2069				2070-2099			
	avg	min	max	stdev	avg	min	max	stdev
TACCIMO	783	731	827	36	801	705	875	56
Climate Wizard	784	679	828	34	793	642	875	49
	Temperature (°C)							
	2040-2069				2070-2099			
	avg	min	max	stdev	avg	min	max	stdev
TACCIMO	13.4	12. 7	14.1	0.5	14.6	13.2	15.7	1.0
Climate Wizard	13.1	11.1	14.3	0.7	14.3	12.5	16.6	1.0
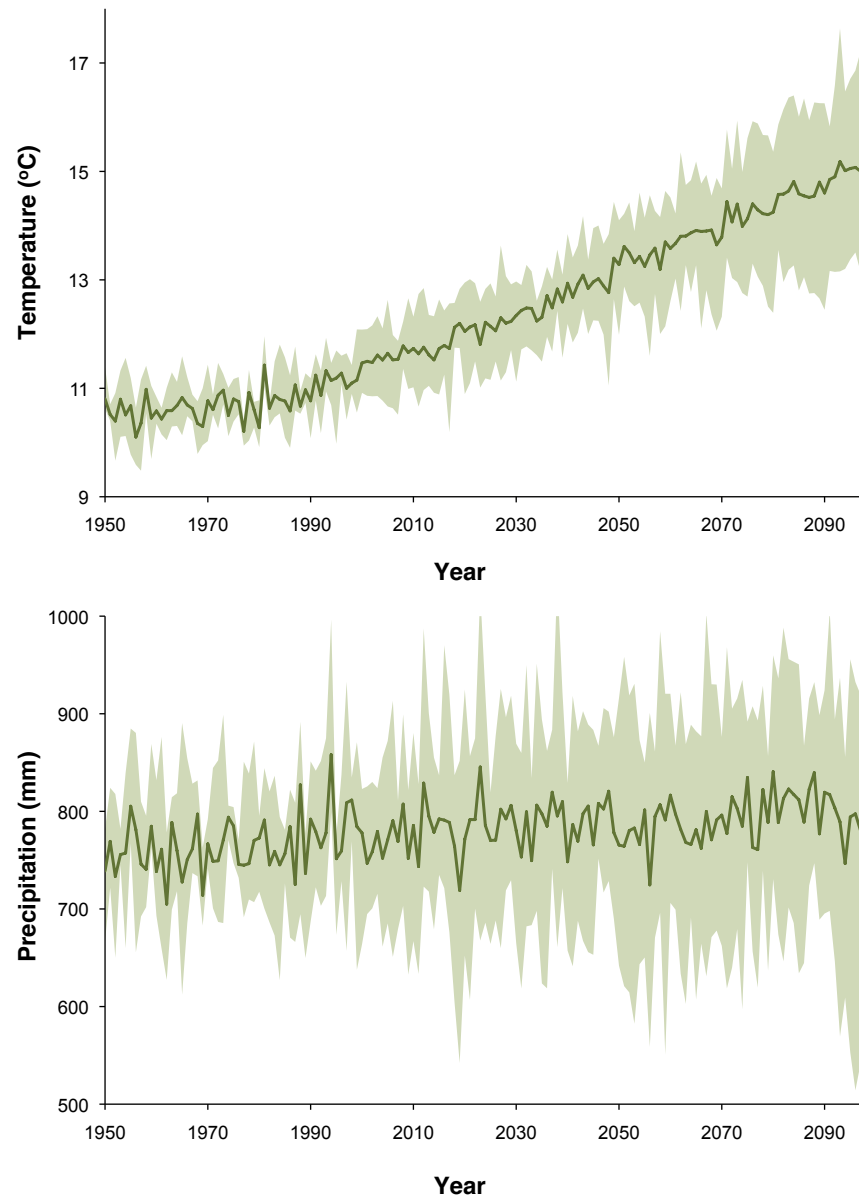
Figure B.3—Summary of national average annual temperature and precipitation projections available in TACCIMO's GIS Viewer (Source: Meehl and others 2007).

Decadal averages of monthly precipitation and temperature data were selected to represent current, mid-century, and late-century predictions. The decadal interval was chosen to reduce the variability that a single year or several years of predictions might contribute to the predictions. Ten years of monthly climate data (e.g., 2045-2054) were averaged to create one decadal average (e.g., 2050) precipitation and temperature value for each ~12-km climate grid cell. An additional processing step was required for precipitation data: multiplying each monthly mean by the number of days in the month to derive monthly totals.

Review and Maintenance—All geospatial data and related metadata are reviewed for accuracy and completeness before being published in the GIS Viewer. New data are added to ArcGIS geodatabases, and metadata documents (overview and detailed) are updated to include information on resolution, spatial extent, temporal extent, citations, attributes, and data availability.

Content Guidance—The following general guidelines apply to the geospatial content available from TACCIMO:

Purpose—The climate change forecasts and models available through TACCIMO are intended to help users begin evaluating trends in climate and the derivative impacts of climate change on other natural resource characteristics (e.g., water supply, suitable habitat) at multiple spatial and temporal scales. In the most general case, results may be applied to discussion of climate trends independent of any consideration of the impacts that these trends might have. In other more specific cases, results may be applied to a particular analysis where either temperature or precipitation change plays a direct role.

Strengths—The ability to spatially explore and capture downscaled climate forecasts and models provides users with the critical context information necessary to evaluate literature-based science. The GIS Viewer enables consideration of forecasts and models with respect to context layers relevant to management and planning. The Climate Report rapidly summarizes the range of climate change projections to help users begin considering the potential magnitude, direction, and timing of change specific to their location.

Limitations—Though useful for establishing the likely range of future climate conditions, forecasts and models have limited utility to near-term projects and are subject to evolving assumptions about how temperature and precipitation will respond to elevated atmospheric CO_2 at different locations. Climate projections are the best information available but should be considered with caution and an appreciation for uncertainty.

Science: Geospatial—Contextual and Complementary Data

Contextual and complementary spatial content is provided to enhance interpretation of primary projections and models. Current resources include FS regions, national and experimental forest boundaries, State boundaries, county boundaries, ecoregional provinces, watersheds (12-digit hydrologic unit codes), and project-specific case study layers. In addition, basemap layers containing imagery, streets, terrain, and topographic maps are included.

Content Organization—These datasets are primarily located in TACCIMO's GIS Viewer. In some instances, these data are inputs to primary models or projections (e.g., land cover data). These data can be included in custom maps by using the *Map Print* and *Map Export* tools in the GIS Viewer. Some of these data (i.e., States, counties, and national forests) can be used to define location-specific summaries in the Climate Report.

Content Development—These datasets are incorporated into TACCIMO in response to users' needs, as TACCIMO expands geographically, and as additional primary models and projections are included. National forests with forest plan revisions or pertinent projects, as well as other program and resource areas, are good candidates. It is preferable to access geospatial data through the FS's national data center or regional geodatabases. Otherwise, the TACCIMO development team works directly with users to acquire, process, and publish the geospatial data in the GIS Viewer.

Review and Maintenance—All geospatial data and related metadata are reviewed for accuracy and completeness before publishing in the GIS Viewer. New data are added to ArcGIS geodatabases, and metadata documents (overview and detailed) are updated to include information on resolution, spatial extent, temporal extent, citations, attributes, and data availability.

Planning: Desired Conditions, Objectives, and Design Criteria

Planning content comprises components derived from FS forest plans for Regions 8 and 9 (and one example Region 5 plan). Though initially designed to accommodate FS planning constructs, this content structure is potentially adaptable for use by other planning agencies (i.e., other FS programs and other Federal, State, and private entities). The organizing elements, primary data elements, and metadata of the planning dataset are described in table B.5. Subsequent sections discuss the data elements in greater detail and outline plans for maintaining them.

Content Development and Organization—Planning content is sourced directly from FS forest plans. This section provides a simplified outline of the three principal forest plan components selected for inclusion in TACCIMO. Also provided is discussion of why they are relevant to climate change based on Climate Change Considerations in Land Management Plan Revision (USDA Forest Service 2010a), FS planning guides (USDA Forest Service 2005, USDA

Forest Service 2008b), and feedback from forest planners. The plan components are intended to align with each other and provide a mutually reinforcing planning structure (table B.6). General recommendations for integrating science-based climate change findings into plan components include:

- Climate change risks to sustainability identified in the supporting plan documents (i.e., Current Evaluation Report) establish the context for planning.
- Climate change should be integrated into plan components and not stand alone.
- Plan components should be sustainable under a range of credible climate scenarios.
- Federally listed species should receive consideration with respect to climate change.
- Disturbance recovery guidelines should take into account climate change.

Table B.5—Planning content data elements defined and organized by role in the application

Role	Elements
National forest (NF): The administrative planning unit that the forest plan represents. Heading: The subject matter area that the plan uses to organize components.	Organization
Desired condition: The direction of the forest with respect to sustainability through land management. Objective: A description of measurable and time-specific efforts to reach desired conditions. Standards and guidelines (design criteria): Technical and scientific specifications of management.	Primary
Plan area: The extent to which the plan component is applied (e.g., forest-wide). TACCIMO literature factor: A factor assigned to each forest plan category to build science-planning relationship.	Metadata

Table B.6—Definitions and key characteristics of land management plan components (USDA Forest Service 2005, USDA Forest Service 2008b)

Component	Component definition	Characteristics
VISION: desired conditions	Descriptions of the ecological, economic, and social attributes that characterize or exemplify the desired outcomes of land management.	• Long-term (10-20 years) • Informed by assessment of current versus desired conditions, demand assessment, scenario building • Capture implications of national strategies at unit-level scale • Contain monitoring capacities
STRATEGY: objectives	Measurable, time-specific tracking of efforts to realize desired conditions. Statements are not overly specific or precise, but more detailed than desired conditions.	• Short-term (3-5 years) • Based on trade-off analysis, prioritization, trend analysis, and risk assessment • Contain monitoring capacities
STANDARDS AND GUIDELINES: design criteria	The purpose of the standards and guidelines (design criteria) is to provide the technical and scientifically based specification in which strategies operate.	• Medium-term (5-10 years) • Science and cause-effect relationships as applied to potential projects • Design criteria should be in line with policies as described by the Directives System • Design criteria can build on other sources of information such as best practice guidebooks • Guidelines may be adaptable and responsive to monitoring

Content Criteria—Separating forest plan documents into component parts is typically very straightforward, but careful consideration is given to the context from which plan components are extracted. The following ground rules apply to development of forest plan content:
- Plan component type (i.e., desired condition, objective, design criteria) is determined based on designations made in the plan document. In a few cases, these designations are ambiguous or unclear, and standard definitions of each component are applied to best categorize the component type.
- The full and complete text of each plan component will be extracted and included in the database. Accompanying narratives, tables, maps, and pictures will not be included, but references to them are preserved.
- Plan components may be assigned to only one heading and are identified based on designations made in the plan document. When sub-headings are used in a plan (i.e., more than one level of organizational nesting), the most specific level of categories that is appropriate for the TACCIMO database will be used. In cases where headings are more specific than what is appropriate for TACCIMO, the heading is placed within brackets ([ ]) at the beginning of the quotation.

Metadata—The metadata accompanying each forest plan component include the plan area and related TACCIMO factor (forest plan heading records only).

Plan area—Forest plan components sometimes apply to a given extent on the national forest. At present, TACCIMO includes only content that is "forest-wide" in extent. Metadata are tracked to allow for inclusion of other, more specific areas in the future.

Factor—A factor is the broadest subject-matter organizing element from TACCIMO's scientific literature database. Factors are assigned to relevant forest plan headings to establish the relationship between science and planning elements.

Review and Maintenance—The forest plan content available through TACCIMO is subject to both continuous and episodic forms of review and maintenance. The process is summarized in the following five discrete steps but is ideally a continuous effort:

Plan Review—The development of forest plan content follows the guidelines described in previous sections.

Data Entry—Data entry may occur in parallel with step one or as a separate effort, where content selected in step one is captured in the database through the content management system. This step ensures that all of the necessary organizing and metadata elements associated with each primary content record are captured.

Science Relationship Building—Forest plan content is associated with TACCIMO factors based on plan category relationships.

Ongoing User Review—After the content goes into production, forest planners assess the correctness of planning records. Forest planners are encouraged to help maintain the content between plan revisions, including submitting plan amendments for inclusion in the database.

Plan Assessment Review—The plan content will be re-evaluated with respect to correctness of organization, primary content, and metadata during the plan assessment process leading up to a plan revision. This episodic review will allow developers to examine the content as a whole.

Content Guidance—The following general guidelines apply to the geospatial content available from TACCIMO:

Purpose—Forest plan components are included in TACCIMO to represent existing management direction and capacity. The organizational structure and components selected for inclusion in the forest plan database capture the operational language of forest management and make it readily accessible.

Strengths—The forest plan content enables TACCIMO to link science with forest plan components to help planners identify and assess management options with regard to climate change. In addition, planners can draw on and compare content from multiple plans with potential application beyond climate change considerations.

Limitations—The forest plan content is limited to forest-wide elements. Not all plans contain all three elements or the same level of detail. Introductory or narrative text, graphs, maps, or figures and amendments are not included. Original planning documents should be consulted for clarification and additional context.

Other Resources

Data Elements—TACCIMO maintains a listing of external resources that address questions that TACCIMO cannot or that provide more in-depth analyses of questions that TACCIMO does address. A link with a brief abstract describes each resource.

Content Organization—External resources are included in the Links to Other Resources page in the *About* module of TACCIMO. They are grouped by broad subject areas that align with TACCIMO factors.

Content Development—Selection of external resources should consider the current content offered by the different TACCIMO modules. Users' recommendations or suggestions for external resources are considered.

Review and Maintenance—The TACCIMO development team regularly reviews the external resources to ensure that links are working and versions or releases are current.
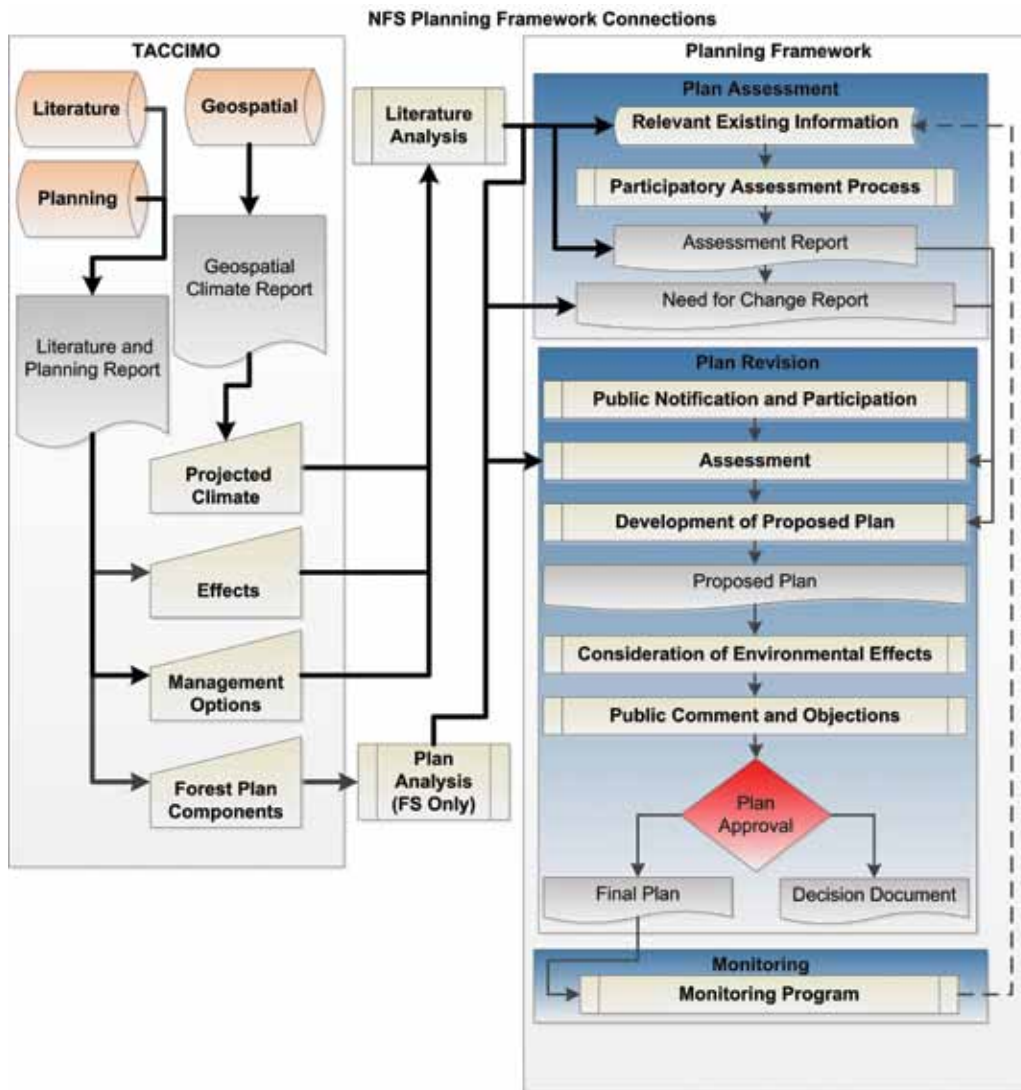
Figure C.1—Flow diagram representing TACCIMO connections with the FS plan assessment and revision process. [Planning framework process summarized from USDA FS (2012b)]

APPENDIX C:
DECISION-SUPPORT CONNECTIONS

Forest Service Land Management Planning—The Forest Service (FS) *Final Programmatic Environmental Impact Statement* (USDA Forest Service 2012a) and resulting preferred alternative *National Forest Service Land Management Planning (Final Rule and Record of Decision)* (USDA Forest Service 2012b) promote the role of planning in adaptive management in general and integration of climate change considerations in the planning processes in particular. The rule discusses climate change implications extensively, including how climate change should be considered in the plan assessment process and later integrated into functional plan components. The underlying goal is to make the planning process more participatory and more responsive to emerging issues and science, a need that TACCIMO directly supports. The FS has also provided supplemental direction in *Climate Change Considerations in Land Management Plan Revisions* (USDA Forest Service 2010a). The planning framework process depicted in figure C.1 is summarized from the text of the *Planning Rule* (USDA Forest Service 2012b) and is intended to represent the specific plan revision process and products, rather than the full adaptive management context used by the FS.

> *Literature Analysis*—The plan assessment requires broad consideration of available information, including the best available science identified during a thorough review and analysis of relevant peer-reviewed scientific literature. TACCIMO provides an initiation point in this process that quickly connects users with relevant climate change science directly applicable to the plan assessment process and report writing (fig. C.1).

> *Plan Analysis*—The existing forest plan represents the starting point for the plan revision, and the plan review works to inform the understanding of "need for change" from existing plan direction. TACCIMO resources can help users identify potential climate change relevance to the existing plan, gaps in both the science and the existing plan, and potential need for change and resulting proposed alternatives (fig. C.1).

National Environmental Policy Act (NEPA) Planning—The National Environmental Policy Act (NEPA 1969) prescribes certain aspects of the decision-support process that Federal agencies use to assess and engage the public regarding the potential environmental impacts of proposed actions. Within the FS, NEPA is applied at multiple scales, most frequently at the project level but also within the previously discussed planning framework. The FS has issued guidance specific to this process (USDA Forest Service 2010b), directing NEPA analysis to consider climate change with respect to work conducted at the project level when scoping identifies climate change issues of concern. Figure C.2 presents connections between TACCIMO and the NEPA process, such as the consideration of best available science to inform proposal development and scoping.

Literature Analysis—The scoping stage of the NEPA process requires consideration of a wide range of information, including best available science and public input. TACCIMO may be used to directly support literature review needs and address public concerns raised during scoping. During an Environmental Assessment, TACCIMO may be used to help identify potential impacts and develop alternatives. If an Environmental Impact Statement is needed, TACCIMO resources can be further utilized to meet the additional information requirements.

Plan Review—The existing forest plan represents important context, establishing the general management direction and other requirements that could inform the proposed action. TACCIMO may assist FS users in participating regions of the NFS by connecting plan components with relevant science. Similar to a literature review, the plan components identified can provide an initiation point in the proposal development process.

Figure C.2—Flow diagram depicting how TACCIMO complements the NEPA process.

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